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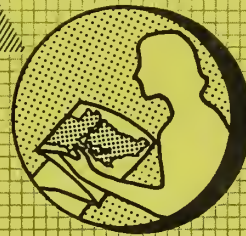
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A GUIDE TO ABAG'S EARTHQUAKE HAZARD MAPPING CAPABILITY

June 1982

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OF BAY AREA
GOVERNMENTS

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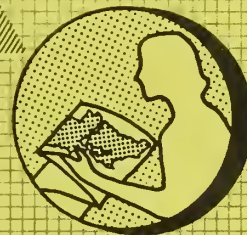
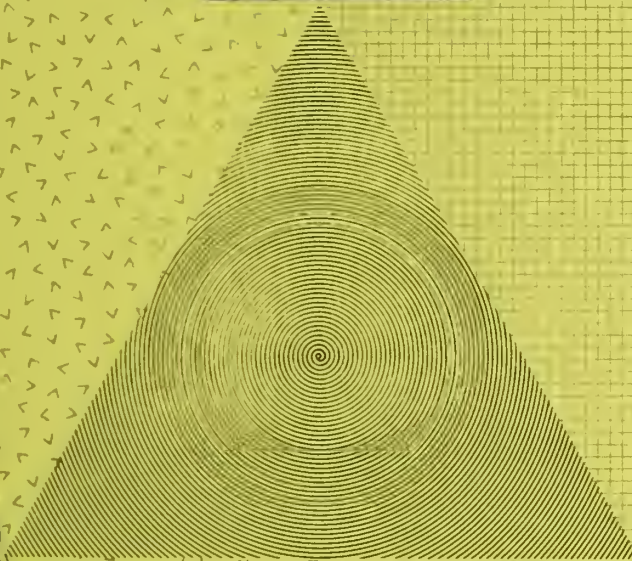
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A GUIDE TO
ABAG'S
EARTHQUAKE HAZARD MAPPING
CAPABILITY

REVISED JUNE 1982

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Association of Bay Area Governments
Hotel Claremont
Berkeley, California 94705
(415) 841-9730

CREDIT:

Jeanne Perkins - Earthquake Program Manager
Don Olmstead - BASIS Program Manager (through March 1981)

OTHER PARTICIPANTS:

Paul Wilson, President of Geogroup Corporation
Paula Schulz
Malcolm Gilmour
Ruth Robinson
Roberta Moreland (BASIS Program Coordinator)

ACKNOWLEDGEMENTS:

We would like to thank those many people at USGS and working for cities and counties in the Bay Area who took the time to review the many papers that form the basis for this guide.

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Introduction
Basic Data Map Files
Hazard Map Files
Map File Applications
Working Papers (Not automatically
included)

White
Yellow
Goldenrod
Green
White

graphics:
Pat Yoshitsu-cover
Merrilee Ollendick
Ross Turner

Typing:
Yvonne McGough
Audrey Will

INTRODUCTION

PURPOSES

Since February 1979, ABAG has been developing a series of computer-based map files showing various basic data maps related to earthquakes and several maps derived from those illustrating various earthquake hazards. The project was started for two reasons:

- o to provide information that could be used by local governments in their seismic safety and safety programs.
- o to provide an input to various other planning programs at ABAG.

FORMAT

This project, unlike many that result in the publication of a final report, will be continuing and various map files will be expanded or upgraded. Therefore, this guide has been designed as a loose-leaf folder so that pages or sections can be replaced or added as ABAG's earthquake hazard mapping capability changes and expands.

The guide contains this introduction and three main sections:

- o a set of sheets describing each of the basic data map files and a cover sheet for that section
- o a set of sheets describing each of the hazard map files and a cover sheet for them.
- o a set of sheets describing several applications for the map files (also with a cover sheet).

The guide has also been designed to include a set of the working papers that have been developed to further describe the assumptions that were made and the data used to develop the hazard maps. A sheet summarizing the Working Papers is at the end of the report.

PROJECT PHASES

The first phase of the project focused on developing an operational earthquake hazard mapping capability and demonstrating some sample uses for researchers and local government technical staff. Files of basic data maps on generalized geology (four bedrock categories), faults, and dam failure and tsunami inundation areas were compiled for the entire nine-county Bay Area. Detailed information on hillside geology, as well as data on landslide deposits and topography, were compiled only for San Mateo County due to the expense of entering these data into the computer system. These basic data map files were manipulated to produce a series

This earthquake mapping project is providing strong technical support for the Earthquake Preparedness Program. It is enabling ABAG staff to conduct land capability type analyses not only for all nine Bay Area counties, but also at the fine resolution of one hectare (2-1/2 acres).

These overlaying and modeling capabilities are extremely important not only for creating the hazard maps in the first place, but also for combining earthquake hazard concerns with other physical and social constraints for site evaluation and impacts analyses.

EARTHQUAKE MAPPING AND THE BAY AREA SPATIAL INFORMATION SYSTEM (BASIS)

This project is closely tied to ABAG's BASIS program. A major objective of BASIS is to develop a regional geographic data base that can be directly used in local, as well as regional, planning applications. It was developed to tie together the data development and map analysis different computers and different resolutions. (The land capability study that used a system at the University of California at Davis was one such application.)

BASIS is structured around an array of grid cells, each representing a land area of one hectare (100 meters square) in the UTM coordinate system. It requires over two million of these cells to cover the nine-county Bay Region. Each cell on the ground corresponds to one unit of computer storage; the unit contains data codes representing the characteristics of that cell. Data can be acquired either by reading a tape or by digitizing a map. BASIS is capable of using data based on other coordinated systems (such as longitude/latitude or LANDSAT reference points) by mathematically transforming these reference systems to a common UTM base. This project greatly increases the data available for each cell. The basic data map files listed in the main body of this guide are a product of direct data acquisition.

Much of the power of BASIS lies in its ability to manipulate the basic data map files. A composite of many data sets can be produced through an overlay or modeling process, and can include distance searches or other calculations. Most of the hazard map files are the product of these processes.

BASIS currently runs on Geogroup Corporation's computer system, which can handle data transfer to or from most other computer systems. The computer configuration includes a digitizer for encoding mapped data, an electrostatic plotter for producing computer maps, and a high resolution dot matrix printer. The V76 computer contains 128K words of fast semiconductor memory and special operations for handling mathematical operations of high speeds. Six terminals on-line to the computer are used for data entry and user interaction. Data storage is on one 88M byte disk drive and one nine-track tape drive. The present computer system (developed by Convergent Technologies) is a cluster of two work stations, each of which contains a processor and 256K bytes of memory. Data storage is presently on one 20M byte disk. A nine-track tape drive and standard floppy disks are used for file back-up and data transfer. Geogroup staff are responsible for all programming work.

BASIS DATA MAP FILES

As of June 1982, the earthquake hazard maps are based on six basic data map files described on the following pages:

- o geology
- o faults
- o topography
- o landslides
- o tsunami inundation areas
- o dam failure inundation areas

In addition, a land use file, and files of selected lifeline systems, have been created to illustrate some applications.

Each of the following sheets consists of five major sections describing various aspects of the map file on the front. The five sections include:

- o Coverage - the area of the region covered (including a map) and the resolution of the data
- o Source - the scale and name of the source used (if many sources are used a working paper containing the complete list may be referenced)
- o Major categories on map - the categories in the file are listed to the extent practicable
- o Used with other files to produce hazard files on - a cross-reference to the hazard map files using this basic data file
- o Limitations and future plans - limitations in coverage or accuracy are described, together with future plans to upgrade each file

A 1:1 million scale reproduction of the file appears on the back for illustration only. At this scale, a complete map explanation would be meaningless. Potential users should contact ABAG staff to obtain maps of their area of interest and an explanation for those maps.

There are other basic files in BASIS that have not been improved in conjunction with this earthquake mapping project. These files can be divided into two categories, files depicting the physical environment and those depicting the social environment:

PHYSICAL ENVIRONMENT

- o average annual precipitation - region-wide
- o vegetation - region-wide
- o National Flood Insurance Program maps - unincorporated areas and some cities
- o flood-prone areas defined by U.S.G.S. in 1972 - region-wide
- o coastline features from U.S.G.S. 7-1/2 minute quadrangles - region-wide
- o soil associations (generalized from soils types) - region-wide
- o average yield from wells - region-wide
- o digital terrain tape elevations - region-wide.
- o slope stability (generalized to 25 hectare resolution) - region-wide
- o air quality problem areas - region-wide

SOCIAL ENVIRONMENT

- o 1970 census tracts - region-wide (1980 census tracts are available for selected applications)
- o county boundaries - region-wide
- o city sphere-of-influence boundaries - region-wide
- o airports, seaports, vacant industrial lands - region-wide
- o landfill sites and service areas



GEOLOGY

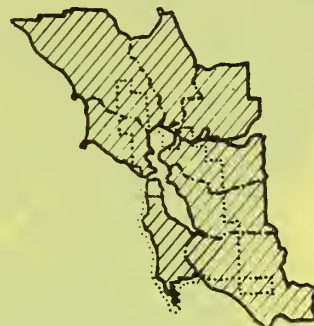
BASIC DATA MAP FILE

COVERAGE: All Bay Area counties with the central Bay Area in more detail

SOURCE:

SCALE: 1:62,500 and 1:24,000 (for geology) and 1:125,000 (for flatlands deposits)

NAME: U.S.G.S. Professional Paper 944-- Flatlands deposits of the S.F. Bay Area; Geology Maps by various U.S.G.S. and C.D.M.G. authors (see Working Paper #17 for more information).



June 1982
Hectare resolution

MAJOR CATEGORIES ON MAP:

Holocene stream channels
Holo. alluvium - coarse
Holo. alluvium - fine
Holo. basin deposits
Quaternary colluvium
Holo. beach and sand deps.
Holo. Bay mud
Artificial fill
Pleistocene sand
Pleis. marine terrace
Pleis. alluvium - coarse
Pleis. alluvium - fine
Late Pleis. alluvium
Early Pleis. alluvium
Colma Formation
Montezuma Hills Formation
Quaternary undivided (urban)
Franciscan Assemblage (General)
Granitic rocks (General)

Materials of Quat./Tertiary age (General)
Other Tertiary or older materials (General)

ADDED FOR THE CENTRAL BAY AREA:

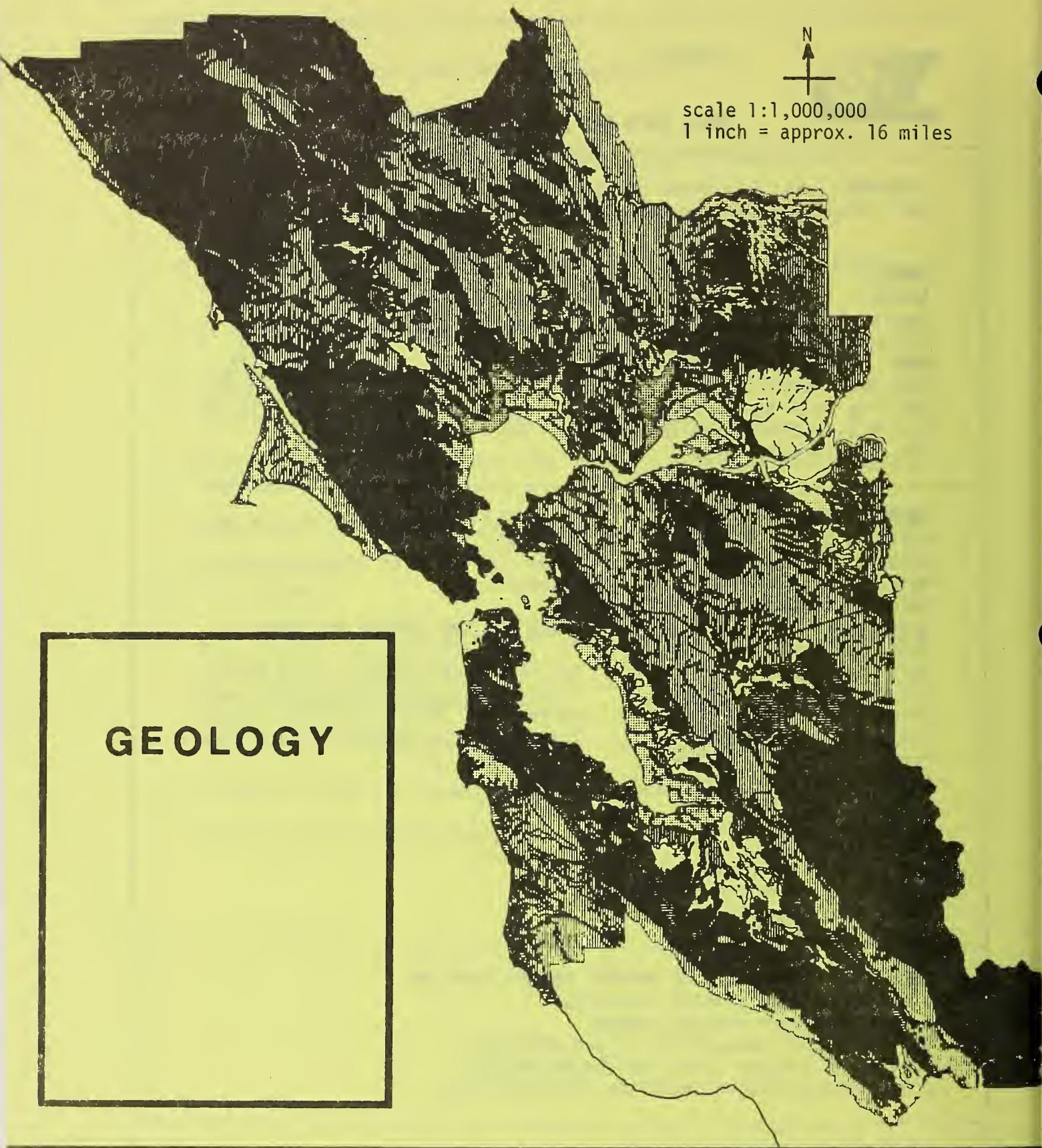
The last four categories are broken into 104 geologic formations and members. For example, the Franciscan is subdivided into many rock types.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction susceptibility and potential
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility

LIMITATIONS AND FUTURE PLANS:

The geology file currently is available only in detail for 46 quadrangles. The level of detail will be increased for other areas as time and money become available.



B A S I S

**BAY AREA SPATIAL
INFORMATION SYSTEM**



FAULTS

BASIC DATA MAP FILE

COVERAGE: All Bay Area counties and parts of adjacent counties

SOURCE:

SCALE: Largely 1:24,000 with some at 1:60,000, 1:125,000, and 1:250,000

NAME: Special Studies Zones Maps prepared by the State Geologist and additional mapping of fault traces by U.S.G.S. personnel of faults they consider active or probably active. (See Working Paper #17 for a list of sources for the mapping used.)



June 1982
Hectare resolution

MAJOR CATEGORIES ON MAP AS STUDY ZONES:

San Andreas*	Sargent*
Hayward*	Butano
Crosley*	Monte Vista*
Calaveras*	Shannon
San Gregorio*	Greenville
Maacama	Las Positas
Healdsburg*	Verona
Rodgers Creek*	
Tolay*	
Concord*	
Green Valley*	
Antioch*	
Evergreen*	
Pleasanton*	
Serra	
Silver Creek*	
Piercy	
Coyote Creek	

AS FAULT TRACES

Greenville*
Las Positas*
Verona*
Berrocal*
San Joaquin*
Midway*
West Napa*
Cordelia*
Dunnigan Hills*
Faults near Trenton*
Maacama*
East of Santa Rosa*
East of Bennett Valley*
Zayante*
Green Valley*

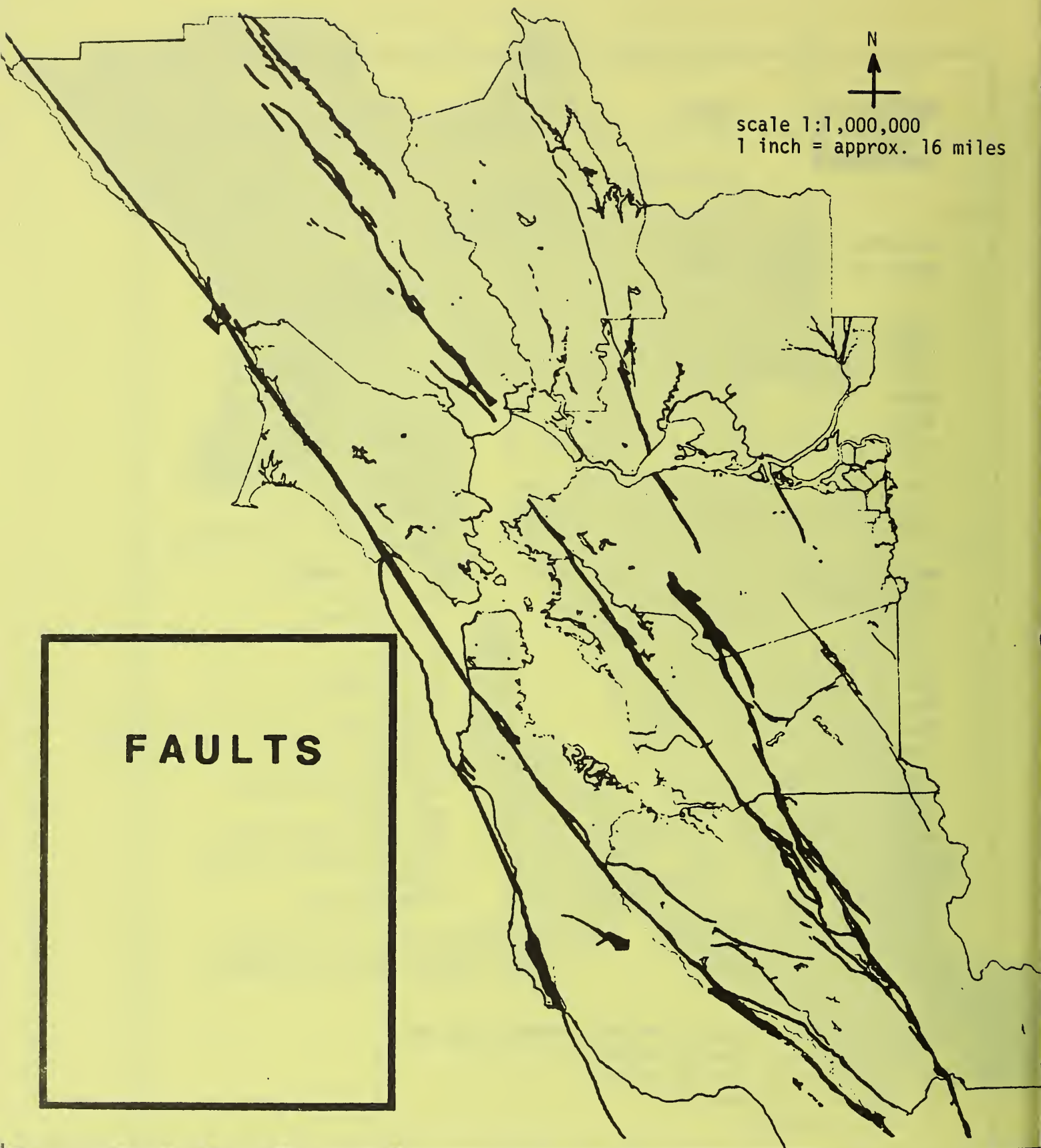
*included in intensity mapping
(main faults only; no branches)

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction potential
- o surface rupture

LIMITATIONS AND FUTURE PLANS:

Changes in Special Studies Zones and in fault traces will be made as new information becomes available. Traces of faults mapped as Study Zones generally are not included. These traces could be added at a future time if money becomes available.



BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



TOPOGRAPHY

BASIC DATA MAP FILE

COVERAGE: The central Bay Area only
(Map on back covers San Mateo County)

SOURCE:

SCALE: Hectare resolution tapes

NAME: Digital terrain model tapes from
U.S.G.S. with elevation accuracy of + or
- 7 meters



June 1982
Hectare resolution

MAJOR CATEGORIES ON MAP:

Average elevation, in meters, for each hectare

In addition, where the digital elevation model data is available, a program has been run to produce the maximum slope by using the maximum change in elevation between any given cell and the eight surrounding cells (allowing for the longer distance between the cell and those at the four diagonal corners). Other ways of producing slope files could be produced at the request of potential users. The slope file is currently stored as six categories:

0 - 5% slope

5 - 15% slope

15 - 30% slope

30 - 50% slope

50 - 70% slope

100+% slope

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility

LIMITATIONS AND FUTURE PLANS:

The topography file is available only for the central Bay Area. The file will be expanded further as money becomes available. When using this file, one should remain aware of the limitations in elevation accuracy (within 7 meters) and spatial accuracy (one hectare for most applications).

**PERCENT
SLOPE**

BASIS



scale 1:250,000
1 inch = approx. 4 miles



LANDSLIDES

BASIC DATA MAP FILE

COVERAGE: The central Bay Area only
(Map on back covers San Mateo County)

SOURCE:

SCALE: 1:62,500

NAME: Preliminary Map of Landslide Deposits in San Mateo County, CA (1972) by Earl Brabb and Earl Pampeyan of U.S.G.S. (Misc. Field Studies Map MF-344) based on aerial photos with some field checking and some use of local government records and consultants reports.



June 1982
Hectare resolution

MAJOR CATEGORIES ON MAP:

- Large landslide - definitely present
- Large landslide - probably present
- Large landslide - of questionable presence
- Large landslide - definitely present, of questionable activity
- Large landslide - probably present, of questionable activity
- Large landslide - field checked and definitely active
- Small landslide - mapped from aerial photographs
- Small landslide - mapped in the field
- Small landslide - subsidence of road or ground from public sources
- Small landslide - active landslide mapped from public sources
- Small landslide - active landslide mapped by private firm

In addition, an area of historic liquefaction (from the 1906 earthquake) in San Mateo County is included on this file based on data supplied by Les Youd of U.S.G.S.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility
- o liquefaction susceptibility and potential (the area of historic liquefaction)

LIMITATIONS AND FUTURE PLANS:

The file is available only for the central Bay Area. The file will be expanded further as time and money become available. The file has been set up to allow for the inclusion of data from local government files and consultants reports. This data, even for San Mateo Co., is out of date.

LANDSLIDES

BASIS



scale 1:250,000
1 inch = approx. 4 miles



TSUNAMI INUNDATION AREAS

BASIC DATA MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE:

SCALE: 1:125,500

NAME: Map Showing Areas of Potential Inundation by Tsunamis in the San Francisco Bay Region, CA (1972) by J.R. Ritter and W.R. Dupre of U.S.G.S. (Misc. Field Studies Map MF-480) based on a 500-year event. See Working Paper #6.



March 1980
Hectare resolution

MAJOR CATEGORIES ON MAP:

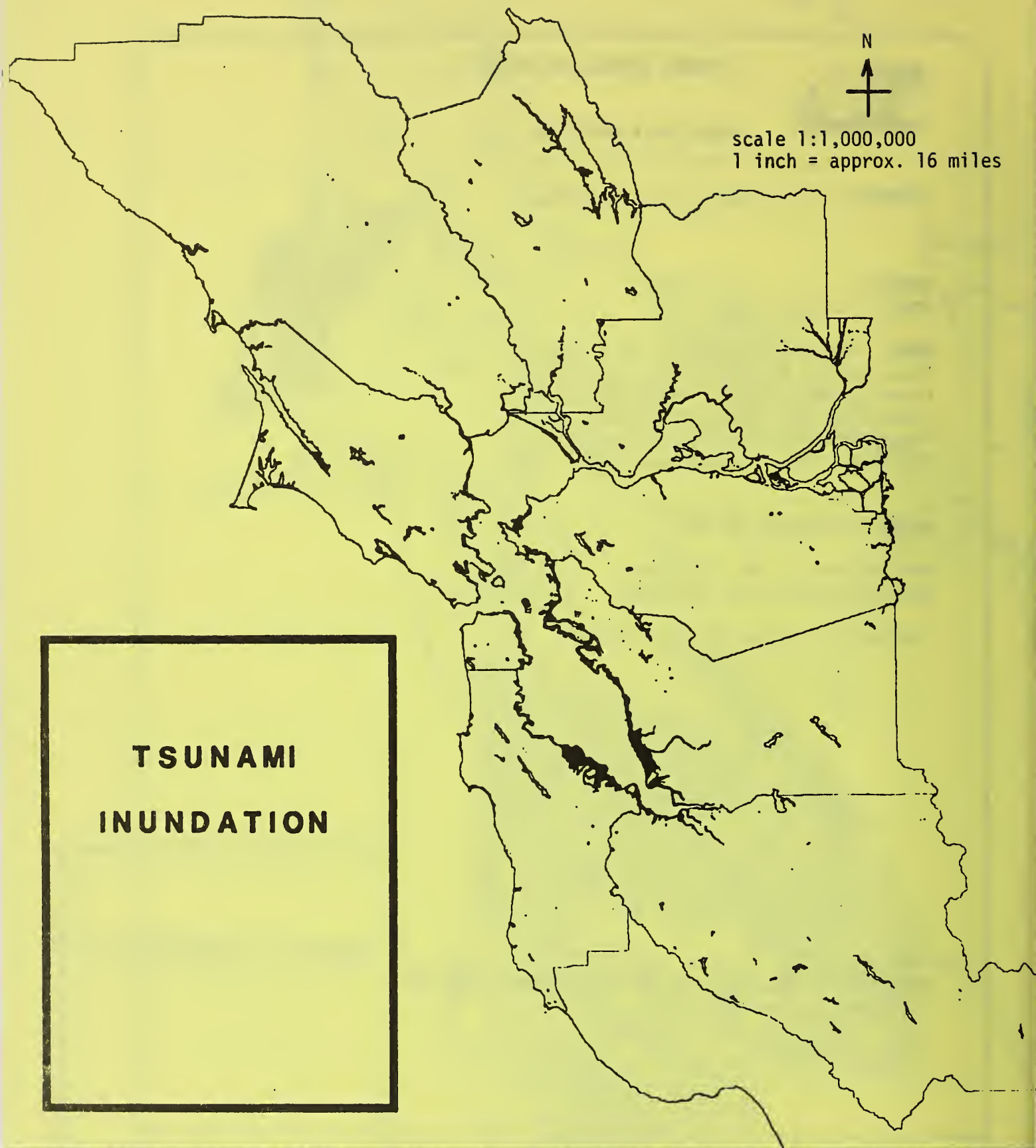
Within areas to be inundated
Outside areas to be inundated

(no depth information is provided)

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:
o tsunami inundation areas

LIMITATIONS AND FUTURE PLANS:

More detailed mapping showing depth of inundation currently is not available in usable form. However, special studies being done in conjunction with the Federal Flood Insurance Program should be available by early 1981. The possibility of replacing this file with more detailed information will be examined at that time.



BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



DAM FAILURE INUNDATION AREAS

BASIC DATA MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE:

SCALE: Originals from 1:2,400 to 1:24,000 all redrafted at 1:24,000

NAME: Maps submitted by dam owners to the California Office of Emergency Services to comply with the California Dam Safety Act (Section 8589.5 of the Government Code) for those dams or reservoirs whose total failure would cause injury or loss of life.



March 1980
Hectare resolution

MAJOR CATEGORIES ON MAP:

For each of the 134 dams where inundation maps were required:
within the inundation area
outside of the inundation area
(no depth information is provided)

The dams for which maps are provided include:

- 28 in Alameda County
- 24 in Contra Costa County
- 4 in Marin County
- 16 in Napa County
- 6 in San Francisco
- 11 in San Mateo County
- 28 in Santa Clara County
- 9 in Solano County
- 7 in Sonoma County
- 1 from Mendocino County affecting Sonoma County

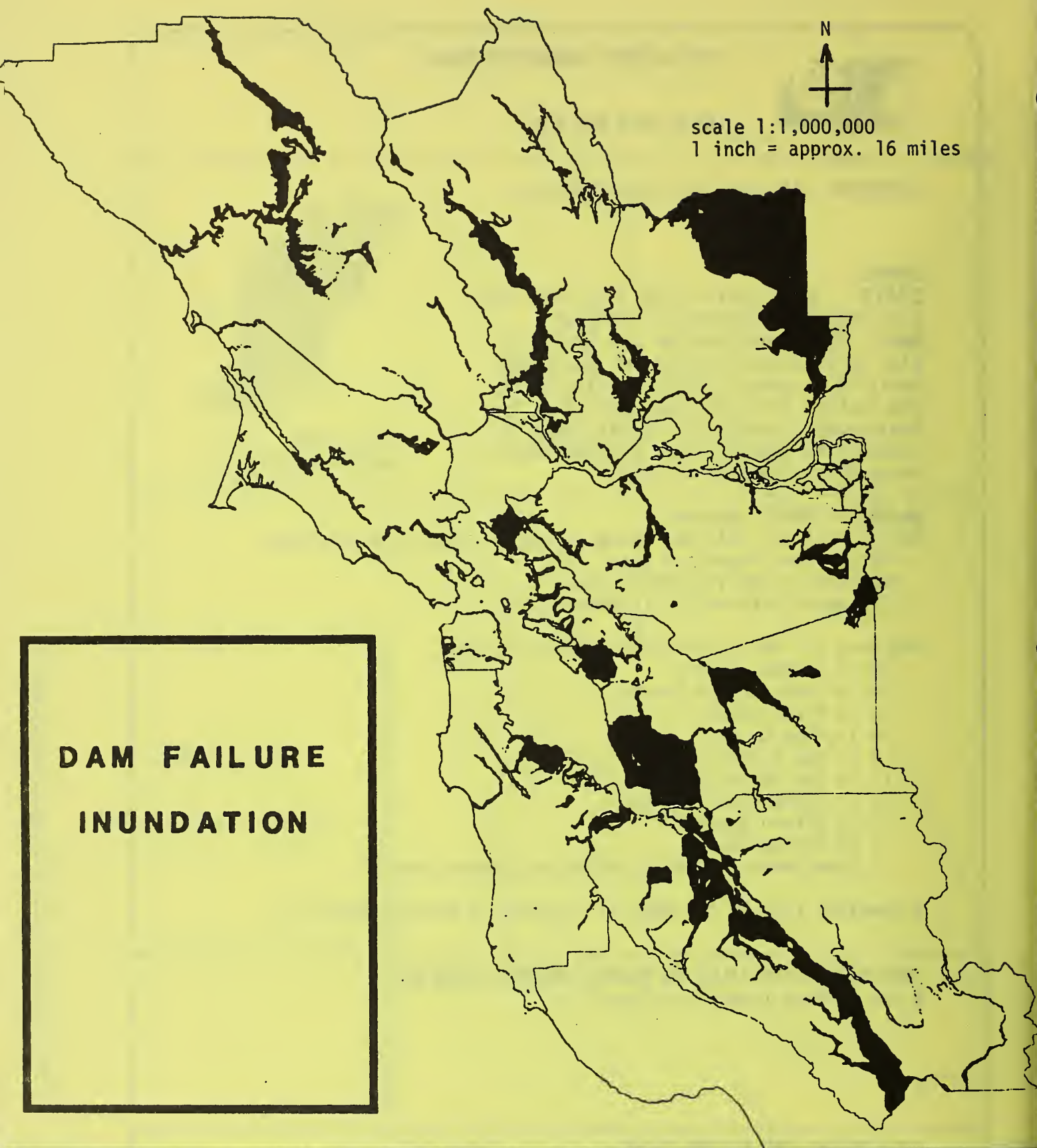
A complete list of the dams is included in Working Paper #7.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

o dam failure inundation areas

LIMITATIONS AND FUTURE PLANS:

The State Department of Water Resources established the criteria to be used by the dam owners to produce the maps and reviewed the completed maps for compliance with the criteria. The file does not contain information on depth of inundation although this information is available from some of the dam owners.



BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



LAND USE--1975-1976

BASIC DATA MAP FILE

COVERAGE: San Mateo County only

SOURCE:

SCALE: 1:24,000

NAME: Land Use and Land Cover Maps prepared by U.S.G.S. showing four levels of land use categories; the maps are published as U.S.G.S. Open File Maps 78-738 to 78-755 and use the classification of Anderson and others of U.S.G.S. described in Prof. Paper 964.



March 1980

Hectare resolution

MAJOR CATEGORIES ON MAP:

Urban or Built-up Land

Residential
3 sub-categories
Commercial and services
7 sub-categories with
1 further subdivided
Industrial
2 sub-categories
Transportation,
communication and
utilities
6 sub-categories
Commercial and industrial
complexes
Mixed urban or built-up
land
Other urban or built-up
land
4 sub-categories with
1 further subdivided

Agricultural Land

Cropland and pasture
2 subcategories with
1 further subdivided
Orchards, groves, vineyards,
nurseries and ornamental
horticulture
3 sub-categories
Confined feeding operations
Other agricultural land

Rangeland

Herbaceous rangeland
Shrub and brush rangeland
2 sub-categories
Mixed rangeland

Forest Land

Deciduous forest land
Evergreen forest land
3 sub-categories
Mixed forest land

Water

Streams and canals
Lakes
Reservoirs
Bays and estuaries

Wetland

Forested wetland
Non-forested wetland

Barren Land

Dry salt flats
Beaches
Sandy areas other than
beaches
Bare exposed rock
Strip mines, quarries
and gravel pits
Transitional areas
2 sub-categories
Mixed barren land

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:

o used only on applications

LIMITATIONS AND FUTURE PLANS:

This file is only available for San Mateo County. A file for the entire region of only the first two levels of categories (no sub-categories or further divisions) for the other eight counties in the region could be obtained if time and money become available.



LAND USE
1975 1976

BASIS



scale 1:250,000
1 inch = approx. 4 miles



LIFELINES

BASIC DATA MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE:

SCALE: from 1:24,000 to 1:250,000

NAME: Wastewater discharge mains, treatment facilities and treatment plant service areas; water supply and distribution mains and water service areas; major highways and associated structures; BART stations and lines; railroads; powerlines and fuel pipelines.



June 1982
Hectare resolution

MAJOR CATEGORIES ON MAP:

- o 74 waste water treatment plants with their associated discharge lines and service areas
- o 236 water supply and distribution main segments and 84 water supply agency service areas
- o 1959 highway structures and 211 highway segments
- o 36 BART stations and buildings and 68 line segments with data on line elevation
- o 57 railroad segments with data on owner and whether it is used as a passenger line
- o 13 categories of oil and energy company pipelines
- o 4 categories of powerlines based on voltage or whether they are underground.

USED WITH OTHER FILES TO PRODUCE HAZARD FILES ON:


- o used only on applications

LIMITATIONS AND FUTURE PLANS:

The data is only as accurate as the base maps from which it was taken. Treatment plant service areas and water supply agency service areas are from relatively old maps (1970) with only minor changes.



scale 1:1,000,000
1 inch = approx. 16 miles



**BART
SYSTEM**

BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**

HAZARD MAP FILES

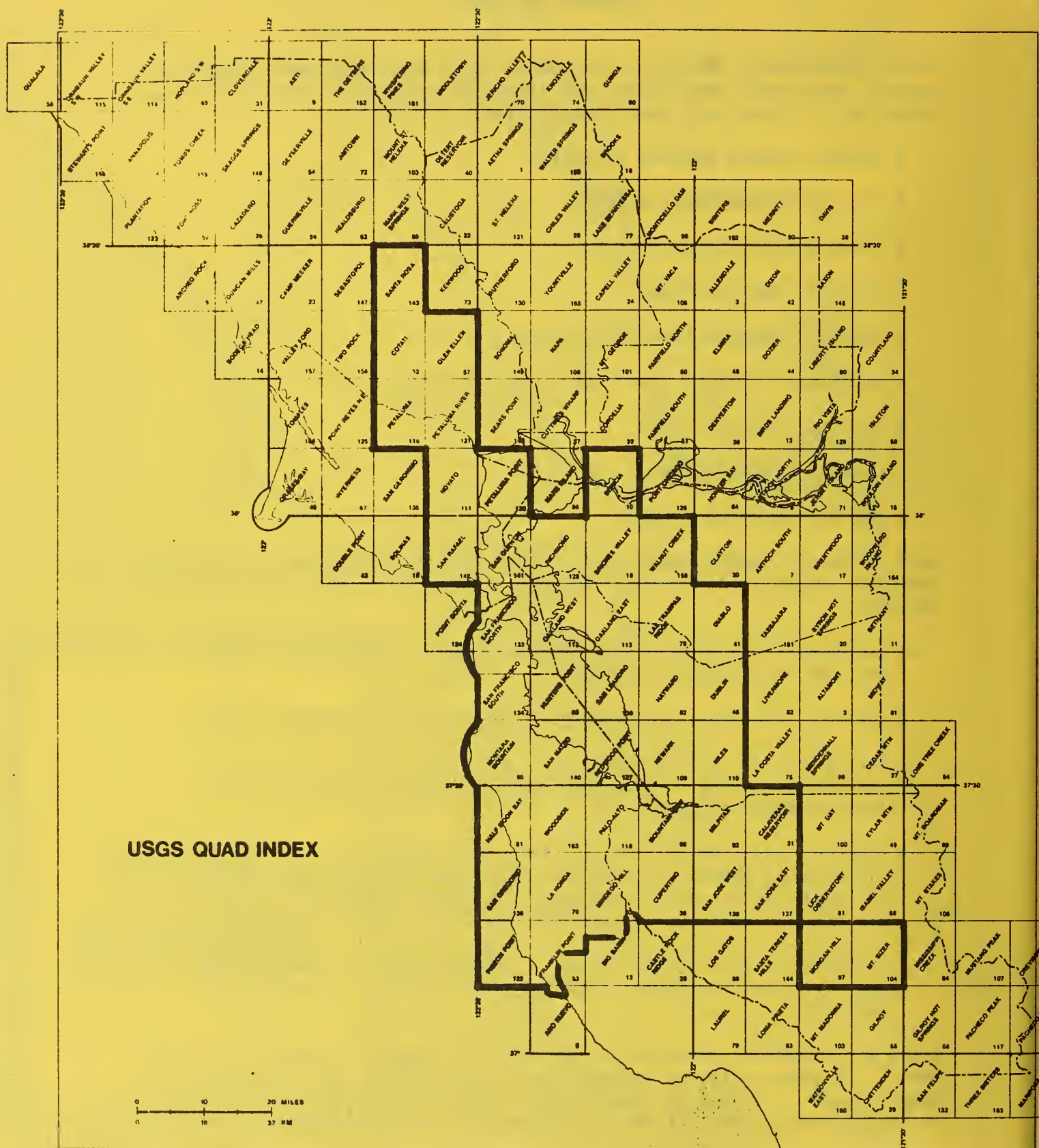
As of June 1982, the first six basic data maps have been combined to create six hazard map files and three of the basic maps have been converted to three additional hazard files:

- o maximum ground shaking intensity
- o risk of ground shaking damage
- o liquefaction susceptibility
- o liquefaction potential
- o rainfall-induced landslide susceptibility
- o earthquake-induced landslide susceptibility
- o fault surface rupture
- o tsunami hazard areas
- o dam failure hazard areas

Each of the following sheets consists of five major sections describing various aspects of the map files on the front. The five sections include:

- o Coverage - the area of the region covered (including a map) and the resolution of the data
- o Source - the basic data map files and the key assumptions used
- o Diagram of components - a figure depicting the interrelationship of the basic data map files used to create the hazard map files
- o Further information on this file is contained in - a list of the working papers further describing the map development and, if applicable, other relevant documents (complete citations are not provided but can be obtained from the working papers)
- o Limitations and future plans - limitations in coverage or accuracy are described, together with future plans to upgrade each file

A 1:1 million scale reproduction of the file appears on the back of each sheet. At this scale, an explanation of individual map categories is meaningless. Potential users should contact ABAG staff to obtain maps of their area of interest and an explanation for those maps.



THE CENTRAL BAY AREA -- THAT PORTION OF THE BAY AREA FOR WHICH ADDITIONAL
BASIC DATA MAPS AND HAZARD MAPS ARE AVAILABLE



MAXIMUM GROUND SHAKING INTENSITY

HAZARD MAP FILE

COVERAGE: All Bay Area counties with the central Bay Area in more detail

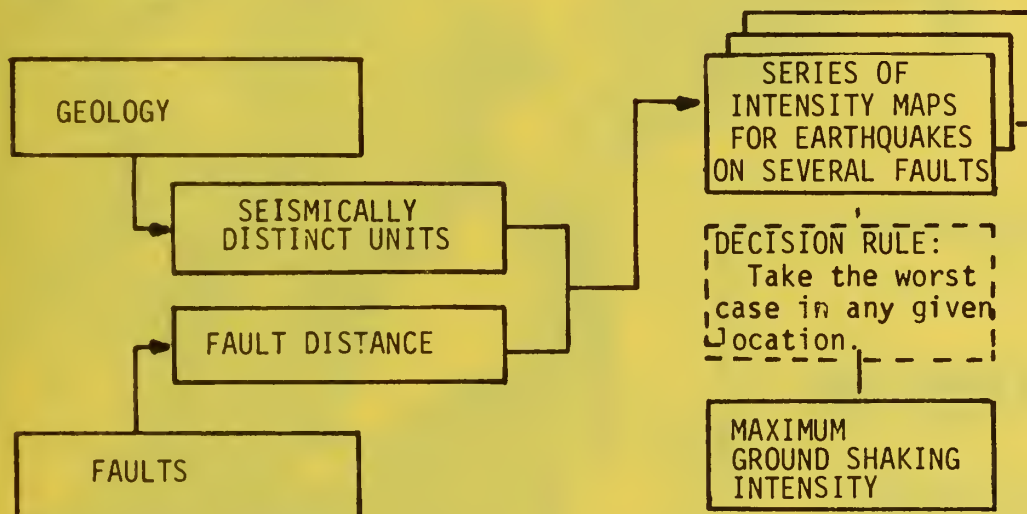
SOURCE: The basic data map files on faults and geology are combined to produce this map using data on:

- o maximum magnitude for each fault
- o maximum intensity associated with each maximum magnitude
- o the attenuation of intensity with distance from the fault rupture
- o the effect of local geology on intensity



June 1982
Hectare resolution

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

Working Paper #17: Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Risk of Ground Shaking Damage

The method is from U.S.G.S. Professional Paper 941-A (Borcherdt & others)

LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between the central Bay Area and the rest of the region can be significant. This file will be recreated as new geology data is entered in the geology file, however. The intensity data is included as San Francisco intensities rather than as modified Mercalli intensities. Data on attenuation for modified Mercalli intensities would change the appearance of this file.



scale 1:1,000,000
1 inch = approx. 16 miles

**MAXIMUM
GROUND
SHAKING
INTENSITY**

BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



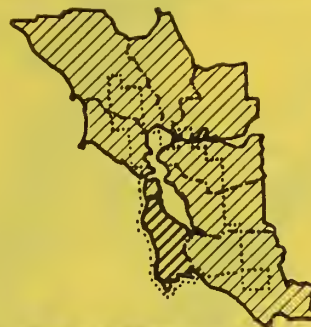
RISK OF GROUND SHAKING DAMAGE

HAZARD MAP FILE

COVERAGE: All Bay Area counties with the central Bay Area in more detail

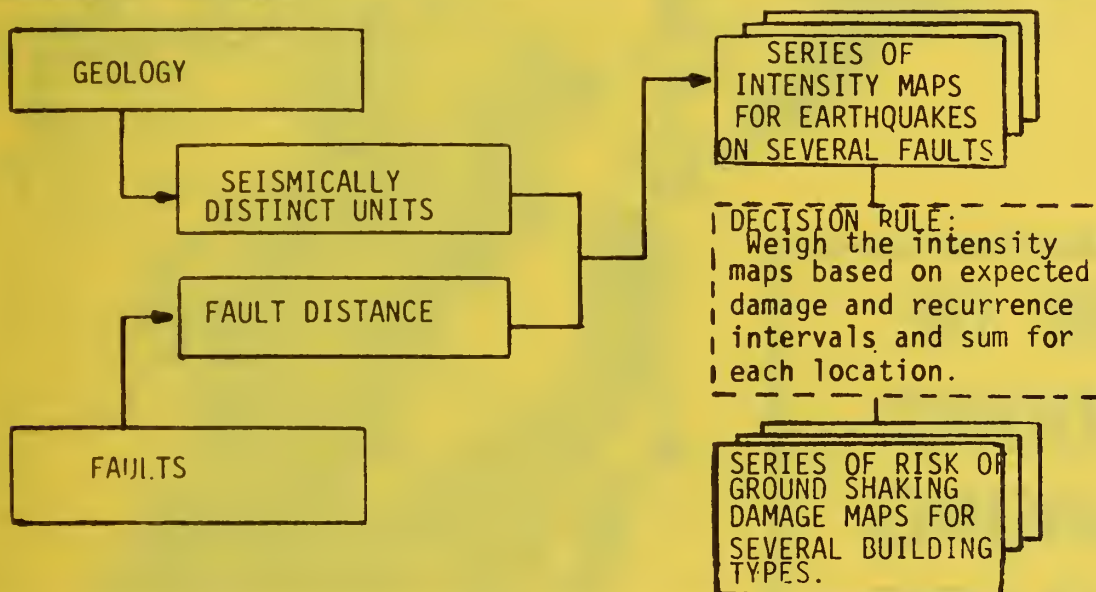
SOURCE: The basic data map files on faults and geology are combined to produce these maps using data on:

- o frequency of different magnitudes of earthquakes on each fault
- o damage associated with intensity
- o the source data used in the maximum ground shaking intensity file



June 1982
Hectare resolution

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #17: Using Earthquake Intensity and Related Damage to Estimate Maximum Earthquake Intensity and Risk of Ground Shaking Damage

The method is a refinement of a technique described in an earlier ABAG publication, Earthquake Intensity and Expected Cost (1978).

LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between the central Bay Area and the rest of the region is fairly insignificant. This file will be recreated as more geology data becomes available. Better data on recurrence intervals of various magnitudes of earthquakes and on the long term slip rate of faults would greatly improve the reliability of the file. The damage data and resulting risk data are statistical and can be applied to building for comparison only.



BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



LIQUEFACTION SUSCEPTIBILITY

HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

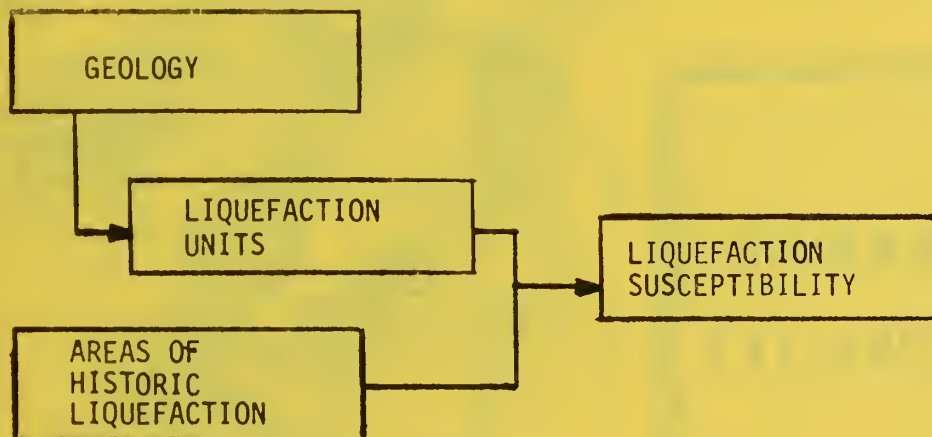
SOURCE: The basic data map file on geology was converted to a hazard file based on:

- o type and age of deposit
 - o extent of cohesionless materials
 - o possibility of cohesionless materials liquefying
 - o likelihood of saturation
- (historic liquefaction areas also included)



March 1980
Hectare resolution

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #4: Liquefaction Potential Mapping

The method is based on several publications of Les Youd and others of U.S.G.S.

LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between the central Bay Area and the rest of the region does not affect this file. If a map of ground water table were available for the region, the data on saturation could be improved significantly.



BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



LIQUEFACTION POTENTIAL

HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

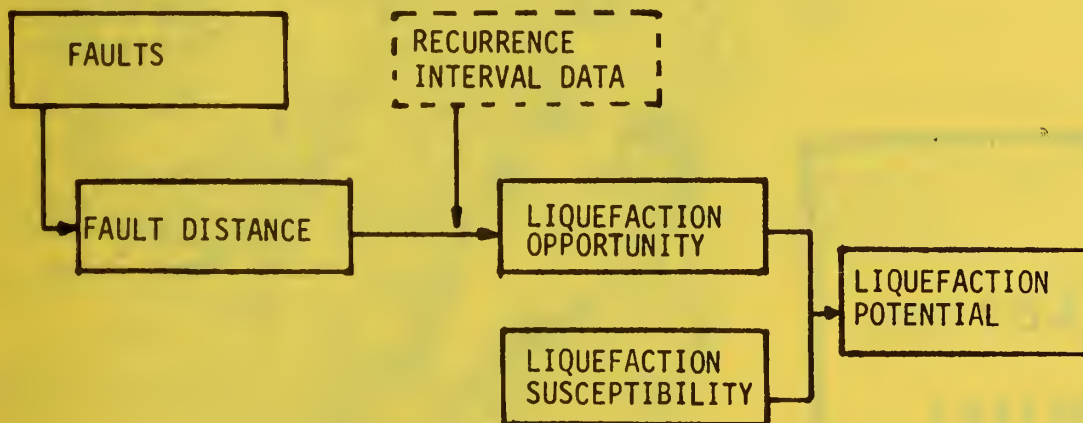
SOURCE: The hazard map file on liquefaction susceptibility and the basic data map file on faults are combined to produce this map using data on:

- o the relative susceptibility
- o the liquefaction opportunity (the frequency of earthquakes)
- o a formula relating magnitude to distance from fault for liquefaction



March 1980
Hectare resolution

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #4: Liquefaction Potential Mapping

The method is based on several publications of Les Youd and others of U.S.G.S.

LIMITATIONS AND FUTURE PLANS:

The difference in the detail of geology information between the central Bay Area and the rest of the region does not affect this file. Any improvements in the liquefaction susceptibility map would obviously improve this hazard map as well. Better information on earthquake recurrence intervals would improve the reliability of this file.



BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



RAINFALL-INDUCED LANDSLIDE SUSCEPTIBILITY

HAZARD MAP FILE

COVERAGE: The central Bay Area only
(Map on back covers San Mateo County)

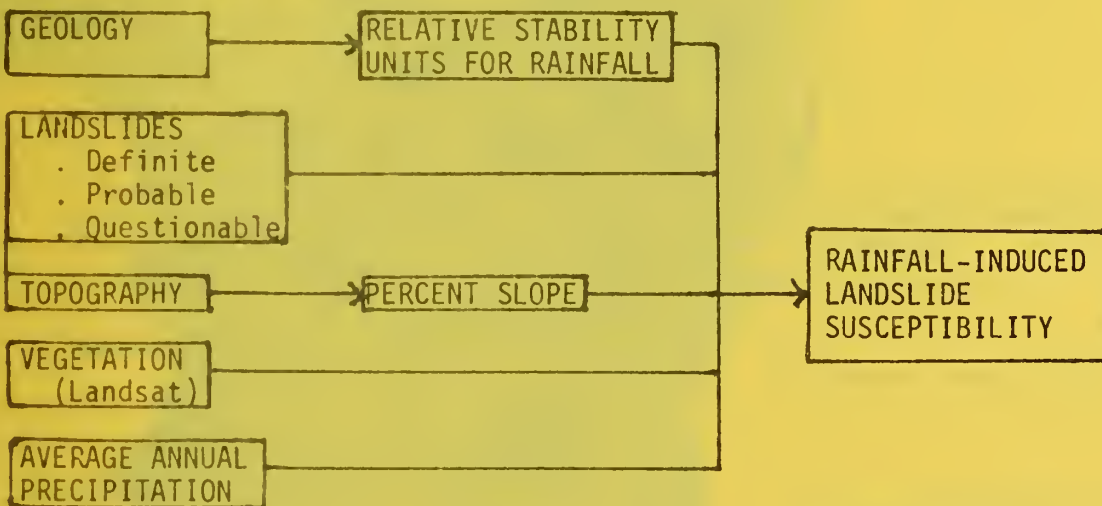
SOURCE: The basic data map files on geology, landslides, annual precipitation and vegetation type and topography (slope) are combined to produce this map using data on:

- o the surface extent of each geologic unit that has failed by landsliding
- o data on percent slope prior to failure
- o the surface extent of selected precipitation and vegetation categories that have failed



June 1982
Hectare resolution

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #5: Slope Stability Mapping
 - o Working Paper #11: The Method Developed to Extend Detailed Map Information Beyond San Mateo County to Selected Areas of Significant Development Pressure.
 - o Working Paper #16: Detailed Map Information for Selected Existing Urbanized Areas and Landslide Susceptibility Hazard Map Refinement
- The method is based on research of Brabb and others at U.S.G.S.

LIMITATIONS AND FUTURE PLANS:

This file currently is available only for the central Bay Area. The landslide susceptibility mapping of Nilsen and others (U.S.G.S. Professional Paper 943) is available in BASIS but at 1/4 sq. km. resolution.

**RAINFALL
INDUCED
LANDSLIDE
SUSCEPTIBILITY**

BASIS



scale 1:250,000
1 inch = approx. 4 miles



EARTHQUAKE-INDUCED LANDSLIDE SUSCEPTIBILITY

HAZARD MAP FILE

COVERAGE: The central Bay Area only
(Map on back covers San Mateo County)

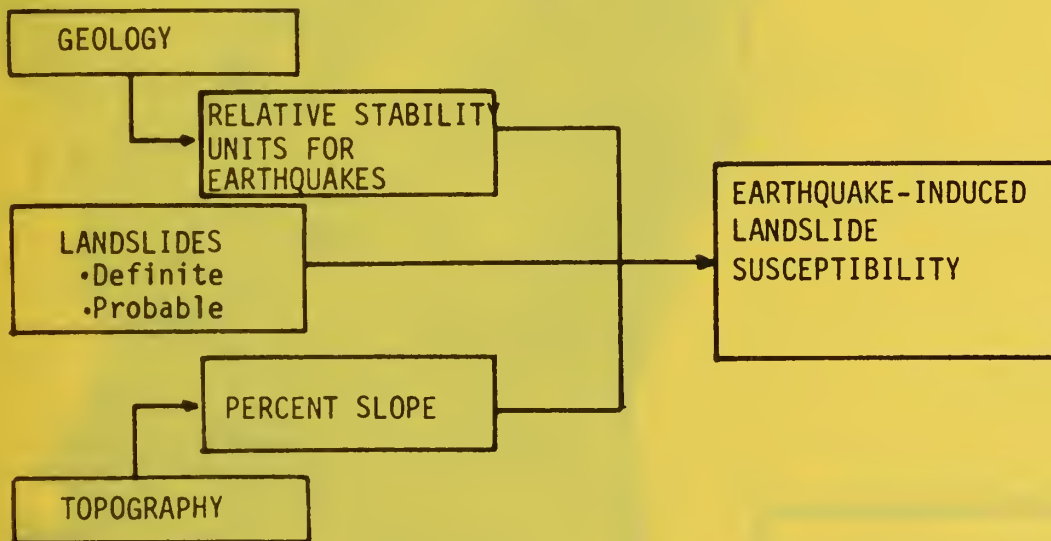
SOURCE: The basic data map files on geology, landslides and topography (slope) are combined to produce this map using data on:

- o physical properties of the geologic units (largely relative cohesion)
- o data on historic failures
- o data on saturation characteristics



June 1982
Hectare resolution

DIAGRAM OF COMPONENTS:



FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #5: Slope Stability Mapping
 - o Working Paper #11: The Method Developed to Extend Detailed Map Information Beyond San Mateo County to Selected Areas of Significant Development Pressure.
 - o Working Paper #16: Detail Map Information for Selected Existing Urbanized Areas and Landslide Susceptibility Hazard Map Refinement.
- The method is based on research of Wieczorek and others at U.S.G.S.

LIMITATIONS AND FUTURE PLANS:

This file currently is available only for the central Bay Area. At the present time, insufficient data is available on landslide opportunity to enable a landslide potential map to be created.

**EARTHQUAKE
INDUCED
LANDSLIDE
SUSCEPTIBILITY**

BASIS



scale 1:250,000
1 inch = approx. 4 miles



FAULT SURFACE RUPTURE

HAZARD MAP FILE

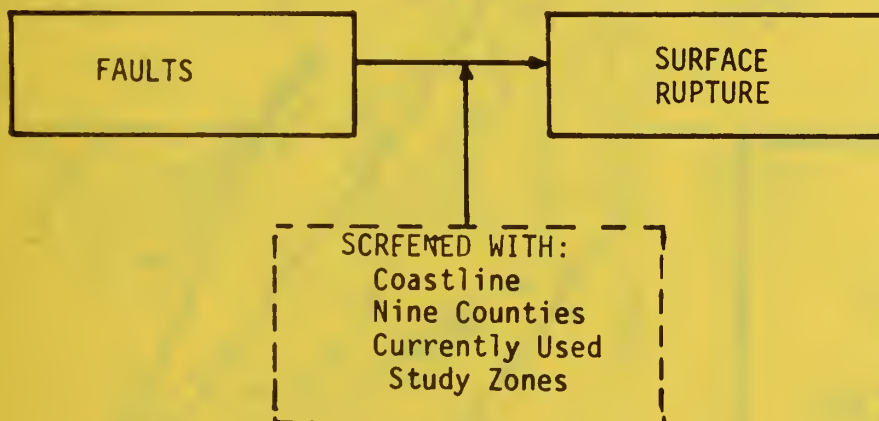
COVERAGE: All nine Bay Area counties

SOURCE: The basic data map file on faults is modified using data on:
o fault activity from U.S.G.S. and C.D.M.G.
o local government requirements



June 1982
Hectare resolution

DIAGRAM OF COMPONENTS:

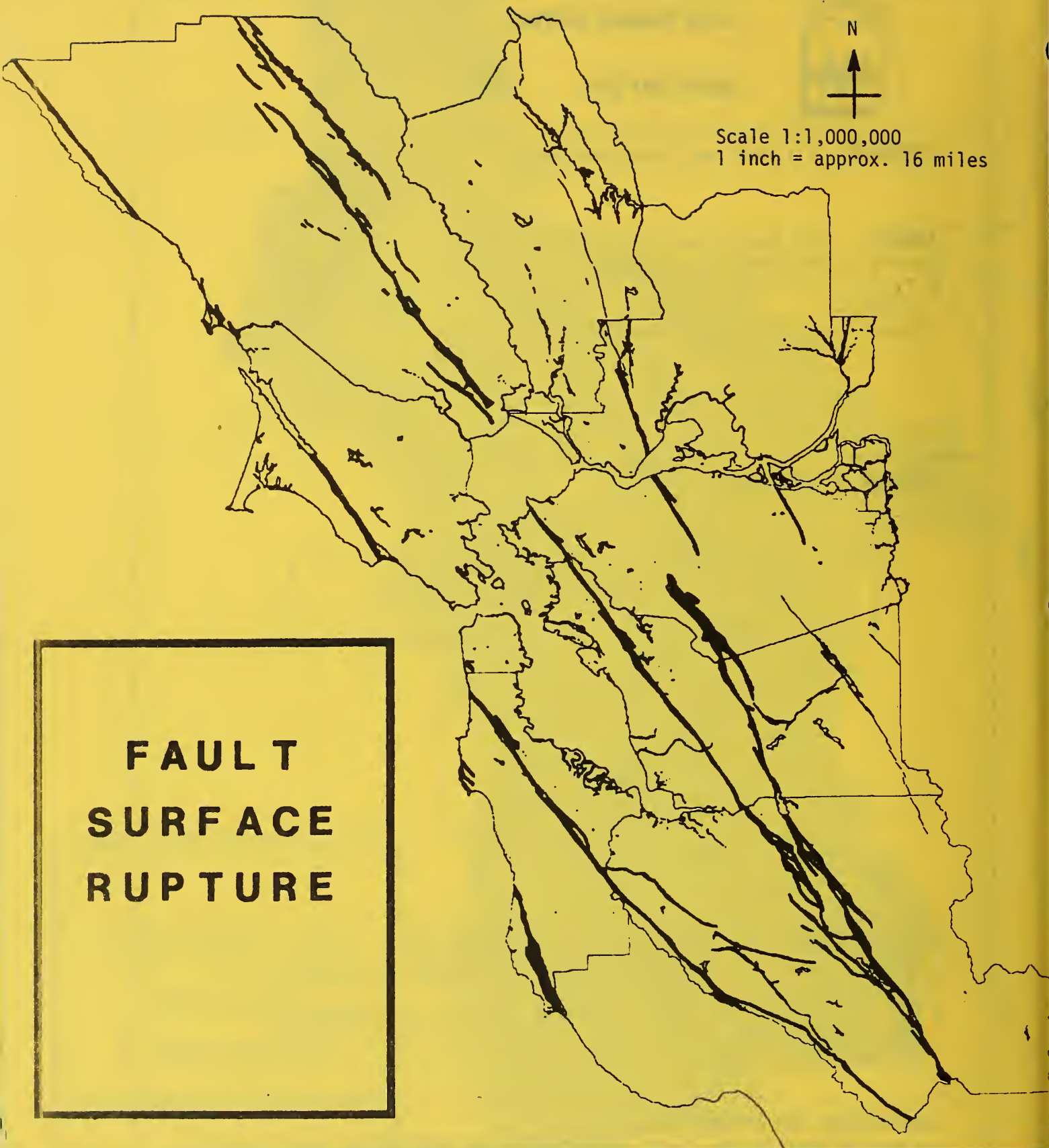


FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #9: Earthquake Map Applications for Composite Earthquake Hazard Mapping
- o Working Paper #17: Using Earthquake Intensity and Relative Damage to Estimate Maximum Earthquake Intensity and Risk of Ground Shaking Damage

LIMITATIONS AND FUTURE PLANS:

As new information on fault activity becomes available, both U.S.G.S. and C.D.M.G. staff will modify the maps used as a basis for this file. The hazard file will be modified accordingly.



**FAULT
SURFACE
RUPTURE**

BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



TSUNAMI HAZARD AREAS

HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE: The basic data map file on tsunami inundation areas is currently the map of tsunami hazard areas. This file is included separately to emphasize that the file could have been created with information on topography and runup.



March 1980
Hectare resolution

DIAGRAM OF COMPONENTS:

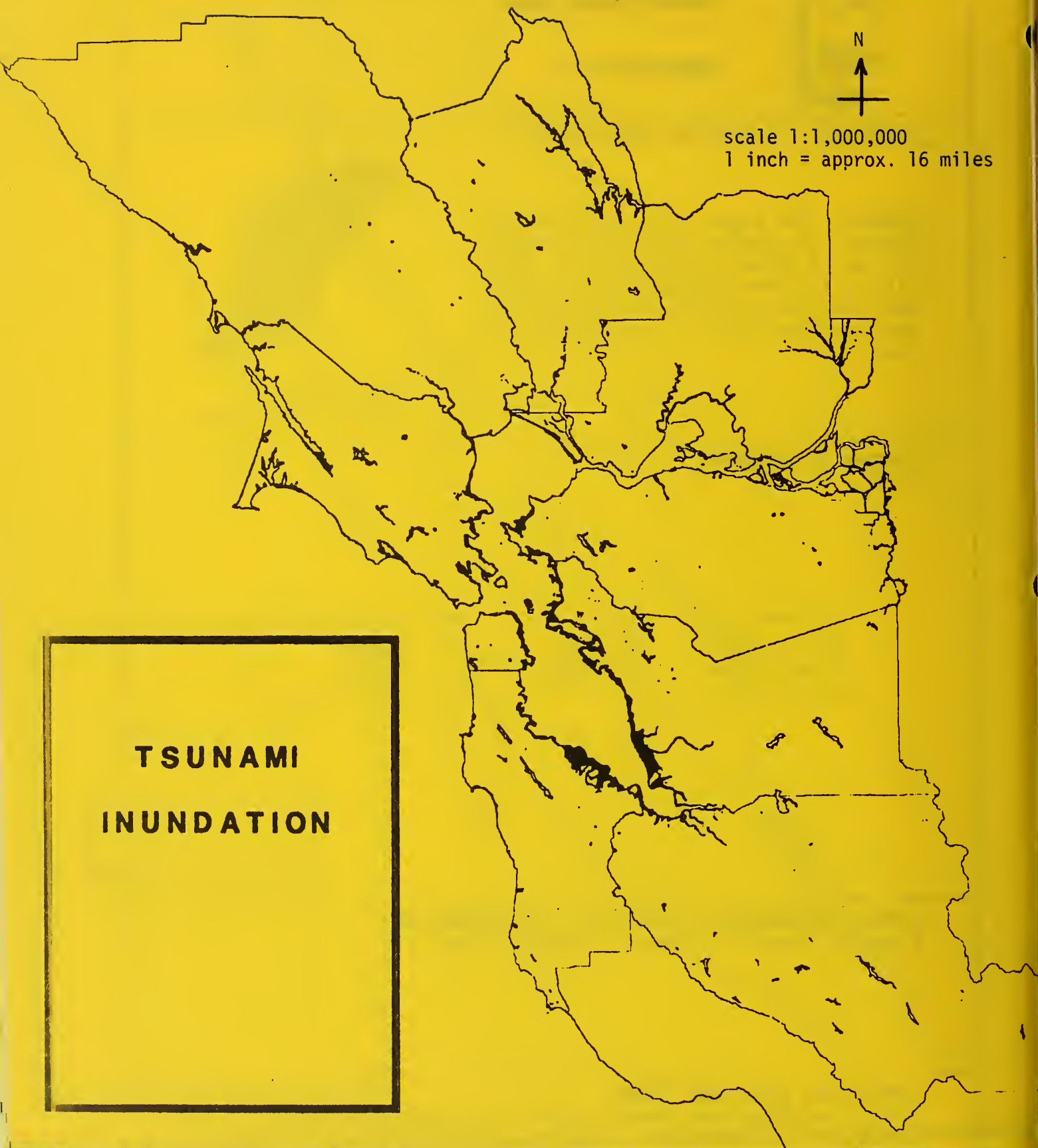


FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #6: Tsunami Inundation Areas

LIMITATIONS AND FUTURE PLANS:

A more detailed map showing depth of inundation currently is not available in a usable form. However, special studies being done in conjunction with the Federal Flood Insurance Program should be available in the future. This file may be replaced with a file that combines data on runup, tsunami, recurrence, and elevation.



BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**



DAM FAILURE HAZARD AREAS

HAZARD MAP FILE

COVERAGE: All nine Bay Area counties

SOURCE: The basic data map file on dam failure inundation areas is currently the map of dam failure hazard areas. This file is included separately to emphasize that the file could have been created with more basic information.



March 1980
Hectare resolution

DIAGRAM OF COMPONENTS:

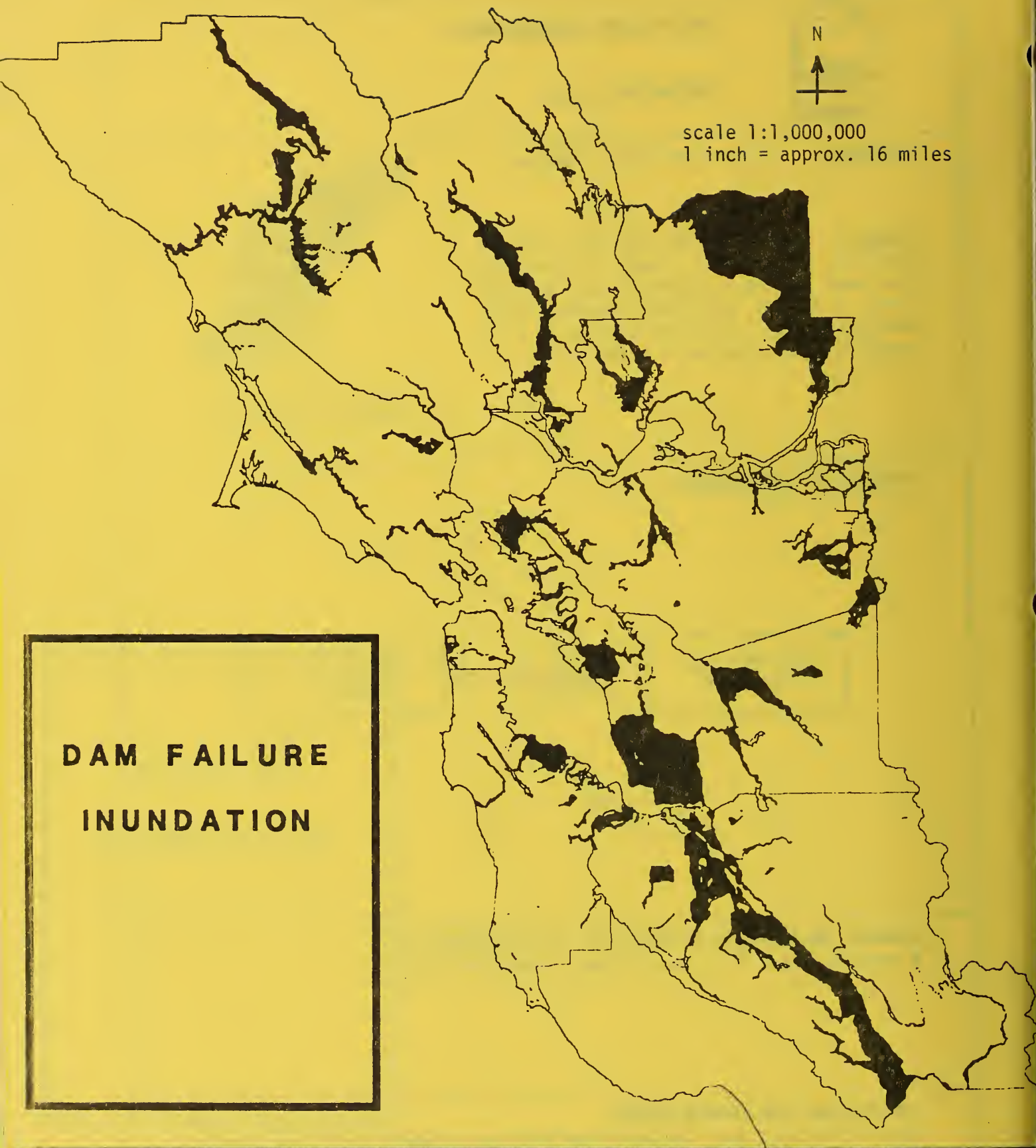


FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #7: Dam Failure Inundation Areas

LIMITATIONS AND FUTURE PLANS:

This file does not contain information on depth of inundation although this information is available from some dam owners. At the present time, little is known on the statistical recurrence of failure of dams, although one would expect that being exposed to earthquakes would increase this rate.



**DAM FAILURE
INUNDATION**

BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**

MAP FILE APPLICATIONS

As of June 1982, these map files can be manipulated for five different types of applications:

- o local general plans
- o computer assisted environmental assessment
- o production of composite hazard maps and site screening
- o assessment of current and projected property and population at risk
- o analysis of lifeline systems

Each of the following sheets consists of five major sections describing various aspects of the applications on the front and a sample of an application product on the back. The five sections include:

- o Coverage - the area of the region covered (including a map) and the resolution of the data
- o Source files - a list of the basic data map files and the hazard map files used
- o Description of product
- o Further information on this file is contained in - a list of the working papers further describing the map application
- o Limitations and future plans - limitations in coverage or accuracy are described, together with future plans to improve ABAG's ability to produce the products described



LOCAL GENERAL PLANS

MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties with the central Bay Area in more detail

SOURCE FILES: Geology; Faults; Topography; Landslides; Tsunami Inundation Areas; Dam Failure Inundation Areas; Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Liquefaction Susceptibility; Liquefaction Potential; Rainfall and Earthquake-Induced Landslide Susceptibility; Fault Surface Rupture



June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:

One of the appropriate ways to use the mapped information is for identifying hazardous areas in a safety or seismic safety element of a local general plan. The latest State General Plan Guidelines for these elements recommend having several maps, most of which are available through ABAG's earthquake hazard mapping work. The table on the back of this page lists those maps available through ABAG that are recommended in the State Office of Planning and Research Guidelines. The cost of these maps depends on the quantity ordered and the map scale specified.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #12: Ordering and Using Earthquake Hazard Maps in Local General Plans

LIMITATIONS AND FUTURE PLANS:

Most maps are available for the entire region. However, the slope, slope aspect, landslide, landslide susceptibility and composite maps are only available for the central Bay Area at this time.



COMPUTER ASSISTED ENVIRONMENTAL ASSESSMENT

MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties with the central Bay Area in more detail

SOURCE FILES: Geology; Faults; Topography; Landslides; Tsunami Inundation Areas; Dam Failure Inundation Areas; Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Liquefaction Susceptibility; Liquefaction Potential; Rainfall and Earthquake-Induced Landslide Susceptibility; Fault Surface Rupture



June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:

This application will produce a background document for development proposals that can be incorporated into the Environmental Impact Report (EIR). This document currently has eleven parts, each focusing on a different social or environmental concern. The part dealing with earthquake hazards is "Geology and Soils--Hazards and Resources". Each section, including the one on geology and soils, contains three parts--setting, impacts, and mitigation. The setting section contains information on five data items: topography, faults, landslides, geologic materials, and soil associations. The impacts section contains information on: rainfall-induced landslide susceptibility, earthquake-induced landslide susceptibility, liquefaction potential, tsunami inundation areas, dam failure inundation areas, maximum earthquake intensities, and earthquake intensity damage and risk. The mitigation section would include those items to be required of the developer by the city or county, including requirements for further study. An extensive list of possibilities is contained in Working Paper #13. The information for each section is presented on a single page. A copy of the impacts section for a hypothetical development is reproduced on the back of this sheet.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #8 : Earthquake Map Applications for Automated Environmental Impact Assessment
- o Working Paper #13: Automated Environmental Impact Assessment - An Update

LIMITATIONS AND FUTURE PLANS:

At the present time because of the limited coverage of the topography, landslide, and landslide susceptibility files, a complete report can be produced only for the central Bay Area. The coverage could be expanded should a city or county request the service and provide funds for file development.

 * SWEENEY RIDGE: AUTOMATED ENVIRONMENTAL IMPACT ASSESSMENT *

GEOLOGY AND SOILS - HAZARDS AND RESOURCES

 IMPACTS

MAXIMUM EARTHQUAKE INTENSITY

	AREA(HECTARES)
A (4)-VERY VIOLENT	0.
B (3)-VIOLENT	36.
C (2)-VERY STRONG	63.
D (1)-STRONG	242.
E (0)-WEAK	101.
NEGLIGIBLE	0.

RISK OF DAMAGE

EXPECTED RISK OF GROUND-SHAKING DAMAGE
 FOR BUILDING TYPES PROPOSED FOR SITE
 (ESTIMATE BASED ON STATISTICAL PROCEDURES
 USING MAJOR FAULT EARTHQUAKE RECURRENCE
 INTERVALS AND AVERAGE BUILDING DAMAGE)

		AREA(HECTARES)		
PRESNT VALUE OF	WOOD FRAME	CONCRETE/STEEL	TILT-UP	
PERCENT DAMAGE	DWELLINGS	BUILDINGS	CONCRETE	
0.0-1.0% MODERATE	442.	406.	343.	
1.1-2.0% *	0.	34.	63.	
2.1-3.0% *	0.	2.	21.	
3.1-4.0% HIGH	0.	0.	13.	
4.1-5.0% *	0.	0.	2.	
5.1-6.0% *	0.	0.	0.	
>6.0% VERY HIGH	0.	0.	0.	

LIQUEFACTION POTENTIAL

	AREA(HECTARES)
VERY LOW	442.
*	0.
*	0.
LOW	0.
*	0.
*	0.
MODERATE	0.

SLOPE STABILITY

RAINFALL-INDUCED
 LANDSLIDE SUSCEPTIBILITY

	AREA(HECTARES)
STABLE	112.
*	316.
*	0.
*	0.
*	0.
*	0.
UNSTABLE	14.

EARTHQUAKE-INDUCED

LANDSLIDE SUSCEPTIBILITY

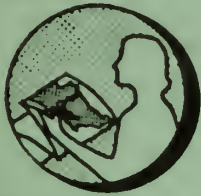
	AREA(HECTARES)
STABLE	294.
*	94.
*	21.
UNSTABLE	31.

TSUNAMI INUNDATION AREAS

	AREA(HECTARES)
INSIDE	0.
OUTSIDE	442.

DAM FAILURE INUNDATION AREAS

	AREA(HECTARES)
OUT OF DAM INUNDATE	442.

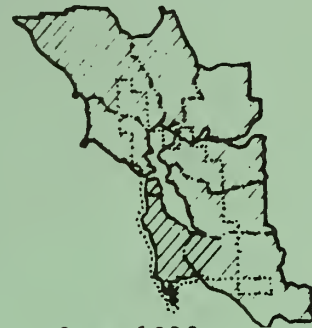


COMPOSITE HAZARD MAPS AND SITE SCREENING

MAP FILE APPLICATION

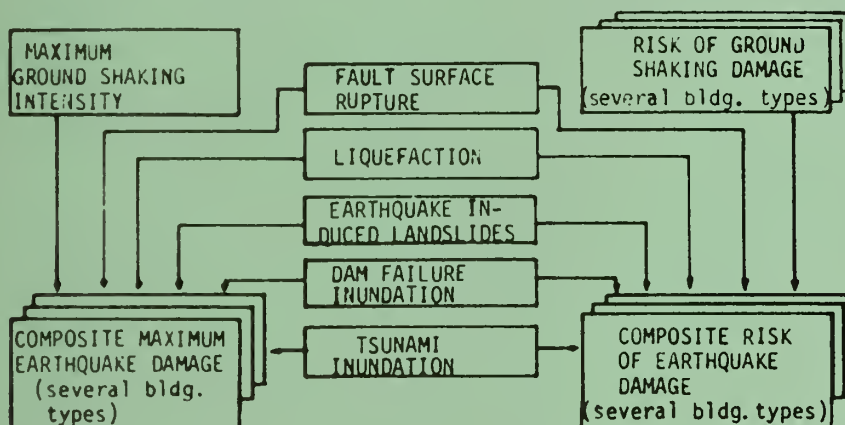
COVERAGE: All nine Bay Area counties with the central Bay Area in more detail

SOURCE FILES: Maximum Ground Shaking Intensity; Risk of Ground Shaking Damage; Fault Surface Rupture; Liquefaction Susceptibility and Potential; Earthquake-Induced Landslide Susceptibility (and Potential when available); Tsunami Hazard Areas; and Dam Failure Hazard Areas



June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:



An example of a composite map appears on the reverse of this sheet. Uses for these maps are described in Working Paper #14.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #9: Earthquake Map Applications for Composite Earthquake Hazard Mapping
- o Working Paper #11: The Method Developed to Extend Detailed Map Information Beyond San Mateo County to Selected Areas of Significant Development Pressure
- o Working Paper #14: Using Earthquake Hazard Maps for Site Screening and Anticipating Mitigation Benefits and Costs

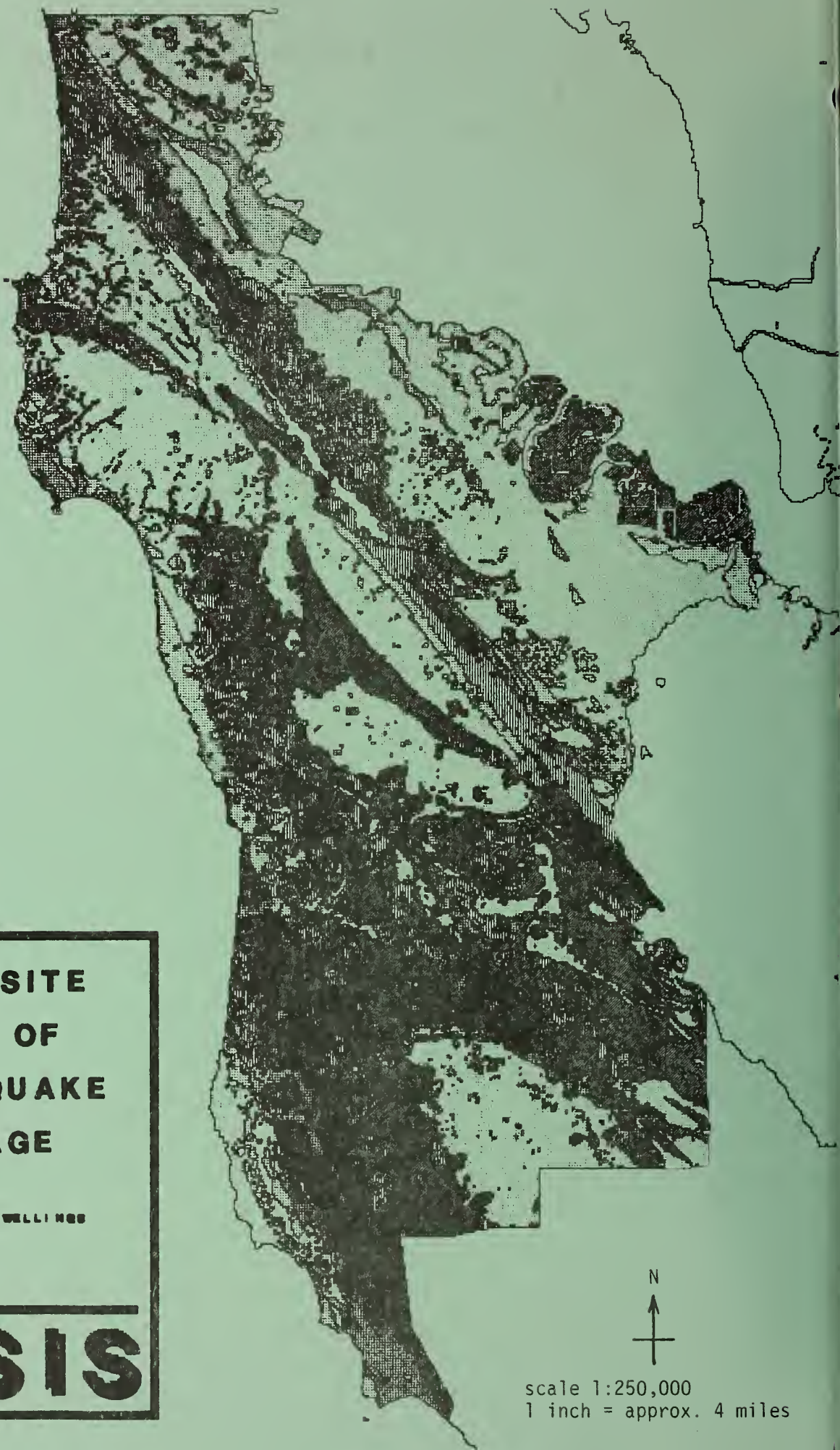
LIMITATIONS AND FUTURE PLANS:

Any composite maps that are produced at this time have two limitations. First, the landslide susceptibility file is only available for part of the region. Second, the lack of information on landslide opportunity in earthquakes makes the production of a landslide potential map impractical. The current data on damage associated with both landslides and liquefaction make composite maps only a rough estimate of areas that are relatively safe.

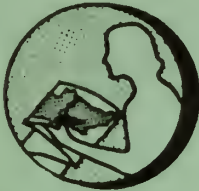
**COMPOSITE
RISK OF
EARTHQUAKE
DAMAGE**

WOOD FRAME DWELLINGS

BASIS



scale 1:250,000
1 inch = approx. 4 miles

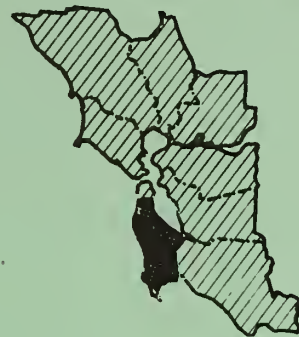


ASSESSMENT OF CURRENT AND PROJECTED PROPERTY AND POPULATION AT RISK

MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties with
San Mateo County in more detail

SOURCE FILES: This application can use
any of the basic data map files or
hazard map files together with the land
use jurisdiction and census tract files.



June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:

This application can produce tables of the amount of land in each
hazard category on each hazard map file by:

- o Census tract
- o City sphere of influence
- o County
- o Land Use

An example of these types of tables is reproduced on the back of this
sheet. Census tract data could be disaggregated by using the land
use data to produce statistics on population at risk. Comparisons of
existing and projected risk in San Mateo County have been made and
indicate that areas of high potential for development are less
hazardous than existing developed areas.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

- o Working Paper #10: Earthquake Map Applications for Automated
Assessment of Property and Population at Risk
- o Working Paper #15: Assessment of Current and Projected Property
and Population at Risk - An Update

LIMITATIONS AND FUTURE PLANS:

At the present time, the land use file is available only for San
Mateo County so some of the more sophisticated applications only can
be performed for that area. In addition, the extent of coverage of
the data files may limit those areas where tables can be produced.

AREA (IN HECTARES) FOR CATEGORIES OF
TSUNAMI INUNDATION
BY JURISDICTION

JURISDICTION	WITHIN	OUTSIDE
<u>Cities</u>		
ATHERTON	0.	1294.
BELMONT	3.	1224.
BRISBANE	10.	554.
BURLINGAME	115.	1102.
COLMA	0.	481.
DALY CITY	0.	2210.
FOSTER CITY	987.	12.
HALF MOON BAY	166.	5606.
HILLSBOROUGH	0.	1642.
MENLO PARK	283.	2719.
MILLBRAE	13.	832.
PACIFICA	116.	3309.
PORTOLA VALLEY	0.	3307.
REDWOOD CITY	1042.	4837.
SAN BRUNO	0.	1526.
SAN CARLOS	0.	1760.
SAN MATEO	218.	3339.
SOUTH SAN FRANCISCO	173.	2320.
WOODSIDE	0.	5474.
<u>Counties</u>		
ALAMEDA	5478.	185588.
CONTRA COSTA	875.	187480.
MARIN	3592.	131332.
NAPA	1.	195672.
SAN FRANCISCO	915.	11154.
SAN MATEO	3554.	112770.
SANTA CLARA	267.	334459.
SOLANO	463.	214945.
SONOMA	890.	409651.
<u>Regional Total</u>		
BAY AREA	16035.	1783051.

AREA (IN HECTARES) FOR CATEGORIES OF
DAM FAILURE INUNDATION
BY JURISDICTION

JURISDICTION	WITHIN	OUTSIDE
<u>Cities</u>		
ATHERTON	111.	1183.
BELMONT	106.	1121.
BRISBANE	0.	564.
BURLINGAME	122.	1095.
COLMA	0.	481.
DALY CITY	0.	2210.
FOSTER CITY	999.	0.
HALF MOON BAY	159.	5615.
HILLSBOROUGH	196.	1486.
MENLO PARK	199.	2803.
MILLBRAE	0.	845.
PACIFICA	0.	3425.
PORTOLA VALLEY	70.	3237.
REDWOOD CITY	276.	5603.
SAN BRUNO	0.	1526.
SAN CARLOS	0.	1760.
SAN MATEO	1874.	1683.
SOUTH SAN FRANCISCO	0.	2493.
WOODSIDE	23.	5451.
<u>Counties</u>		
ALAMEDA	35088.	155978.
CONTRA COSTA	12709.	175646.
MARIN	2578.	132346.
NAPA	10821.	184852.
SAN FRANCISCO	460.	11409.
SAN MATEO	4529.	111795.
SANTA CLARA	39430.	296296.
SOLANO	56536.	158872.
SONOMA	15961.	394580.
<u>Regional Total</u>		
BAY AREA	177112.	1621974.

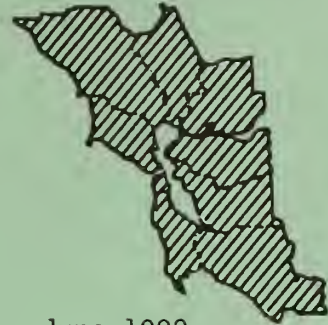


ANALYSIS OF THE VULNERABILITY OF LIFELINE SYSTEM LOCATIONS

MAP FILE APPLICATION

COVERAGE: All nine Bay Area counties

SOURCE FILES: This application can make use of any of the basic data map files or hazard map files together with the lifeline map files.



June 1982
Hectare resolution

DESCRIPTION OF PRODUCT:

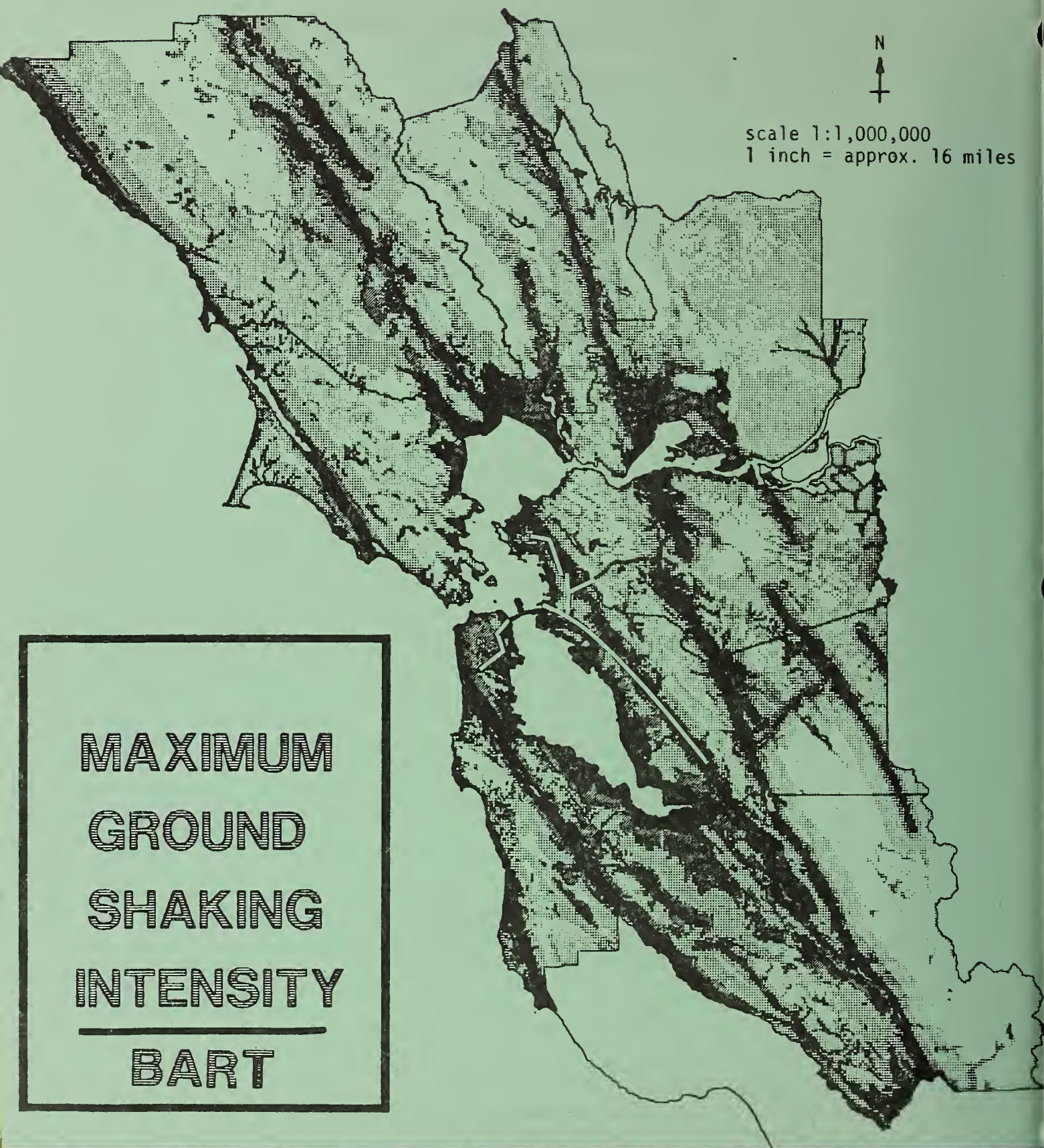
In a sample application of this analysis technique, three main types of lifeline system components -- the networks, key facilities, and service areas -- were examined. The decision was made to concentrate on sewage, water supply, rail and highway systems. Less emphasis has been placed on air and water transportation, solid waste disposal and power systems. Analysis techniques used include area tabulations of hazard level by lifeline type on link, identification of points of concern on networks, a printout of hazards associated with the location of key facilities, and an assessment of hazard levels associated with utility service areas.

FURTHER INFORMATION ON THIS FILE IS CONTAINED IN:

o Working Paper #18: Using Earthquake Hazard
Maps to Analyze the Vulnerability of Lifeline
System Locations

LIMITATIONS AND FUTURE PLANS:

Since the landslide susceptibility mapping is only available for the central Bay Area, tabulations of lifelines in these hazard areas can only be produced for the central Bay Area.



BASIS

**BAY AREA SPATIAL
INFORMATION SYSTEM**

WORKING PAPERS
(as of June 1982)

The working papers referenced in this guide are not automatically included in this document. They can be ordered from ABAG's offices at a small charge. This user's guide, complete with all Working Papers, has automatically been forwarded to the planning director in each city and county in the Bay Area.

The available working papers include:

- #1 - Faults and Ground Shaking Intensity -- replaced by Working Paper #17
- #2 - Attenuation, Geologic Materials and Ground Shaking -- replaced by Working Paper #17
- #3 - Damage and Ground Shaking Intensity -- replaced by Working Paper #17
- #4 - Liquefaction Potential Mapping -- a description of the likelihood of finding cohesionless sediments within a geologic map unit, the likelihood that those sediments (when saturated) would be susceptible to liquefaction, the likelihood of finding those sediments saturated, and liquefaction opportunity (based on recurrence intervals of earthquakes and the distance from various faults at which liquefaction can occur)
- #5 - Slope Stability Mapping -- a description of how slope, geology and existing landslides can be used to estimate landslide susceptibility in an earthquake and under more normal circumstances in San Mateo County
- #6 - Tsunami Inundation Areas -- a description of the data used to develop a tsunami hazard map and of the relative risk associated with tsunamis
- #7 - Dam Inundation Areas -- a description of dam inundation mapping and of the relative risk associated with dam failure
- #8 - Earthquake Map Applications for Automated Environmental Impact Assessment -- a description of how hazard map files can be used to produce a background document for development proposals that can be incorporated into an Environmental Impact Report
- #9 - Earthquake Map Applications for Composite Earthquake Hazard Mapping -- a description of how the various hazard maps can be combined to yield two types of hazard maps of total earthquake associated damage



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